

Ch 9: Cellular Pathways that Harvest Chemical Energy

1. Show, using a diagram, what happens in a redox reaction. Explain briefly.

2. Redox-reactions between metabolites in living cells are often coupled using mobile electron carriers. Name the two most important mobile electron carriers (A and B) in energy metabolism. A is water soluble and is found in the cytoplasm, while B is lipid-soluble and is found in the cell membrane in bacteria, and the mitochondrial inner membrane of eukaryotes.

A:

B:

3. Suggest reactions that do not involve oxidation or reduction, but where energy is released.

4. What is the term “substrate-level phosphorylation” used to describe, and where/when is this process particularly important?

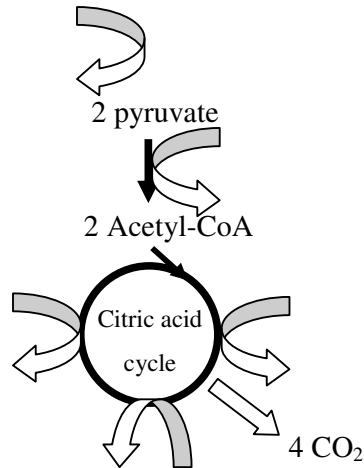
5. How does a muscle cell benefit from producing lactic acid, and when does this occur?

6. Explain which of the following statements about the citric acid cycle are correct:

- occurs in mitochondria
- does not produce ATP
- has no connection with the respiratory chain
- is the same as fermentation

7. In a simplified representation, glycolysis is often represented by an arrow, the citric acid cycle by a circle and the most important substrates and products are given. Add the most important substrates and products to this drawing:

glucose



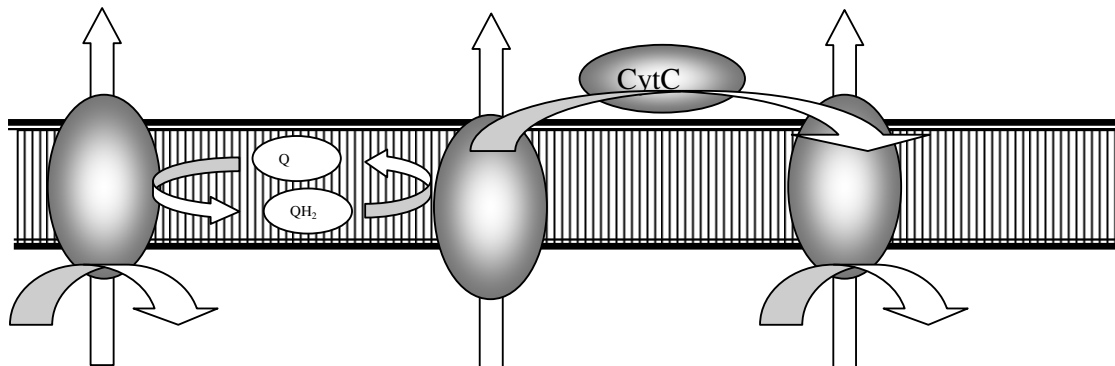
8. Several enzymes in glycolysis and the citric acid cycle are allosterically regulated.

- How does allosteric regulation function?
- Why is it advantageous for the cell, that enzymes in these pathways are activated by AMP and ADP or are inhibited by ATP?
- *Why is it advantageous for the cell, that enzymes in the citric acid cycle are activated by NAD⁺ or are inhibited by NADH?*

9. Which of the following possibilities give the greatest energy yield to an animal cell, if it has sufficient NAD⁺ and ADP, but neither NADH or ATP (explain your answer):

- 1) The addition of x mol ATP
- 2) The addition of x mol NADH

10. Label the missing molecules on the following diagram of the respiratory chain:



11. How do cells attain redox balance (ratio between oxidation and reduction) during respiration and fermentation, respectively?

12. Explain the difference in ATP production per glucose by:

- a) substrate-level phosphorylation
- b) respiration.

13. Commitment step

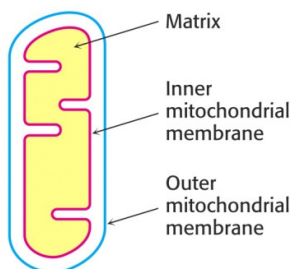
- a) What is "the commitment step"?
- b) Why is the commitment step usually the step in a pathway that is subject to regulation?
- c) Which reaction is the commitment step for glycolysis?
- d) Which enzyme catalyses this reaction, and how is it regulated?

Example exam questions

1. Which of the following statements about the respiratory chain are correct?

- occurs in mitochondria
- uses O_2 as oxidising agent
- regenerates oxidising agents for glycolysis and the citric acid cycle
- occurs at the same time as fermentation

2. Sketch the position of ATP synthase in the mitochondrial membrane and briefly describe the function of the enzyme.



3. Where in a eukaryotic cell do the following occur?

- a) citric acid cycle?
- b) glycolysis?
- c) elektron transport chain?

4. The following reactions may occur, after a polysaccharide has been broken down to monosaccharides like glucose:

Reaction 1: phosphoenolpyruvate \rightarrow pyruvate

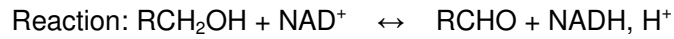
Reaction 2: pyruvate \rightarrow lactate

Explain briefly the significance of each of these reactions for the energy metabolism of the cell.

Reaction 1:

Reaction 2:

5.



a. State which is the reduced and oxidized form of each molecule in this reaction.

b. What does the abbreviation "NAD⁺" stand for?

6. Glucose can be converted by our metabolism to CO₂ og H₂O. Is the overall reaction an oxidation or reduction? Explain your answer.